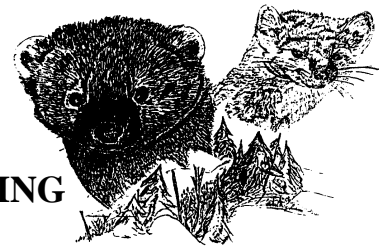


# REGISTERED FURBEARER POPULATION MODELING

## 2012 Report



Drawing by Gilbert Proulx

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### INTRODUCTION

For populations of secretive carnivores, obtaining field-based estimates of population size remains a challenging task (Hochachka et al. 2000; Wilson and Delehay 2001; Conn et al. 2004). This is particularly true when one is interested in annual estimates, multiple species, or large areas. Nevertheless, population estimates are desirable to assist in making management or harvest decisions. Population modeling is a valuable tool for synthesizing our knowledge of population demography, predicting outcomes of management decisions, and approximating population size.

In the late 1970s, Minnesota developed population models for 4 species of carnivores (fisher, marten, bobcat, and otter) to help ‘estimate’ population size and track population changes. All are deterministic accounting models that do not currently incorporate density-dependence. However, juvenile survival adjustments are made for bobcats and fisher during cyclic lows in hare abundance and following severe winters, particularly those where northern deer populations decline. For juvenile marten, survival is adjusted downward during apparent lows in small mammal abundance. Modeling projections are interpreted in conjunction with harvest data and results from any annual field-based track surveys.

### METHODS

Primary model inputs include the estimated 1977 ‘starting’ population size, estimates of age-specific survival and reproduction, and sex- and age-specific harvest data. Reproductive inputs are based largely on carcass data collected in the early 1980s, and for bobcats, additional data collected in 1992 and from 2003-present. Initial survival inputs were based on a review of published estimates in the literature, but are periodically adjusted as noted above. In some cases, parameter adjustments for previous years are delayed until additional data on prey abundance trends is available. Hence, population estimates reported in previous reports may not always match those reported in current reports. Obtaining updated Minnesota-specific survival and reproductive estimates is the goal of ongoing research.

Harvest data is obtained through mandatory furbearer registration. A detailed summary of 2011 harvest information is available in a separate report. Bobcat, marten, and fisher age data is obtained via x-ray examination of pulp cavity width or microscopic counts of cementum annuli from teeth of harvested animals. Although the population models only utilize data for the 3 age-classes (juvenile, yearling, adult), cementum annuli counts have periodically been collected for all non-juveniles either to examine age-specific reproductive output (bobcats) or to obtain periodic information on year-class distribution for selected species. In years where age data is not obtained for a given species, harvest age proportions are approximated using averages computed from the most recent period when data was collected.

For comparison to model projections, field-based track survey indices are presented in this report as running 3-year (t-1, t, t+1) averages of the observed track index, with the most recent year's average computed as (2/3\*current index + 1/3\*previous index). More detailed descriptions of scent post and winter track survey methods and results are available in separate reports.

## RESULTS AND DISCUSSION

**Bobcat.** The 2011 registered DNR trapping and hunting harvest reached a new record level (1,711), exceeding last year's record harvest by 70% (Table 1). Total modeled harvest, which includes reported tribal take, was 1,898. The juvenile to adult female ratio in the harvest (0.8; Table 1) was below both the long-term average (1.5) and the recent 10-year average (1.1). A total of 1,626 bobcat carcasses were examined (Table 1), with a mean age of 3.0 for females. Approximately 10% of the harvested female bobcats were  $\geq 6.5$  years old (Figure 1).

Based on examination of reproductive tracts, 13% of yearling females produced a litter in 2011, the lowest since data collection resumed in 2003 (Figure 2). Average litter size for pregnant yearlings was 2.5, slightly above the previous 8-year average of 2.2. Pregnancy rate for 2+ year olds was 73%, similar to the previous 8-year mean (74%). Mean litter size for pregnant adults was 2.8 (8-year mean = 2.8). For both yearlings and adults, pregnancy rates appear to fluctuate more than average litter size, though neither has shown significant variability or trend since data collection resumed in 2003.

Based on the recently recalibrated bobcat population model, 35% of the 2011 fall population was harvested. As a result of the record harvest, population modeling projects a 12% decline in the bobcat population (Figure 3), with an estimated 2012 spring population size of ~ 3,400 (Figure 3). Both track indices remain at record levels (Figure 3).

**Fisher.** For the past 4 years, the fisher harvest season was reduced from 16 days to 9 days. In addition, the fisher limit was reduced the past 2 seasons from 5 to 2. Fisher harvest this year under the DNR framework increased 63% to 1,473 (Table 2). Modeled harvest, which includes reported tribal take, was 1,651.

Fisher carcass collections were resumed in 2010 to collect current information on age distribution. A total of 1,314 carcasses were collected in 2011 (Table 2). The juvenile:adult female ratio was 3.0, below last year's estimate of 4.3, and well below the 1977-1994 average of 6.6 (Table 2). Average age of harvested males and females was 1.4 and 1.8, respectively. Very few fishers over the age of 2.5 were harvested (Figures 4 and 5).

Based on projections from the fisher population model, 21% of the fall fisher population was harvested during the 2011 season. Although the conservative seasons in recent years appeared to have stabilized the previous decline, this year's harvest may have exceeded current sustainable levels, and the 3-year-averaged winter track index for fisher once again declined, though not significantly (Figure 6). Modeling projects a 7% decrease in the population, with an estimated 2012 spring population size of ~ 6,000 fishers (Figure 6).

**Marten.** As with fisher, the marten harvest season the last 4 years was shortened from 16 days to 9 days, though the marten limit has remained unchanged. Harvest this year under the

DNR framework was 2,525, up 37% from last year (Table 3). Modeled harvest, which includes reported tribal take, was 2,744. Age-class information was obtained from a sample of 70% of the carcasses collected this year. Juveniles comprised 39% of the total harvest, slightly below the recent 10-year average (46%), and well below the longer-term average of 55% (Table 3; Figure 7). The juvenile:adult female ratio (2.6) in the harvest was below both the recent 10-year average (4.6) and the longer-term average (7.6; Table 3).

Based on projections from the marten population model, 22% of the fall marten population was harvested. After declining for ~ 8 years, the 3-year-averaged winter track index has been rebounding after implementing more conservative harvest seasons. However, the higher than expected harvest this year appears to have dampened the recovery (Figure 8). Modeling projects a 6% decline in the population from last year (Figure 3), with an estimated 2012 spring population size of ~ 9,000 martens.

**Otter.** From 1977 - 2007, otter harvest was only allowed in the northern part of the state. From 2007-2009, otter harvest was allowed in 2 separate zones with differing limits (4 otter in the north zone, 2 in the southeast zone). Beginning in 2010, otter harvest was allowed statewide, with a consistent limit of 4 otter per trapper. Statewide harvest in 2011 under the DNR framework increased 26% to 2,294 (Table 4), of which approximately 50 (2%) were taken in the former southeast zone and 90 (4%) in the recently opened SC/SW portion of the state.

Modeled statewide otter harvest, which includes tribal take, was 2,490 (Table 4). An estimated 17% of the fall population was harvested. Carcass collections ended in 1986, so no age or reproductive data are available. After the population declined for several years as a result of high fur prices (harvests) and then rebounded to previous levels as fur prices (harvests) declined, modeling indicates that this year's harvest had a stabilizing effect on the population (Figure 7). The 2012 spring population is estimated to be ~ 12,300, essentially unchanged from last year.

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Table 1. Bobcat harvest data, 1982 to 2011.

Year	DNR Harvest	Modeled Harvest <sup>1</sup>	% Autumn Pop. Taken <sup>2</sup>	Carcasses Examined	% juveniles	% yearlings	% adults	Juv: Ad. Female ratio	% male juveniles	% male yearlings	% male adults	Overall % males	Mean Pelt Price <sup>3</sup>
1982	274	320	15	261	35	15	50	1.3	47	49	47	48	\$66
1983	208	212	10	205	37	26	37	1.5	54	53	30	45	\$61
1984	280	288	15	288	37	13	50	1.4	52	66	44	51	\$76
1985	119	121	6	99	33	19	48	1.2	41	41	43	42	\$70
1986	160	160	8	132	26	17	57	0.9	53	32	51	51	\$120
1987	214	229	12	163	33	16	51	1.4	44	52	48	48	\$101
1988	140	143	7	114	40	18	42	1.7	58	62	46	54	\$68
1989	129	129	6	119	39	17	44	2	49	53	56	53	\$48
1990	84	87	4	62	20	34	46	0.8	58	80	44	59	\$43
1991	106	110	5	93	35	33	32	3.6	59	55	70	61	\$37
1992	167	167	7	151	28	22	50	1.2	55	45	53	53	\$28
1993	201	210	8	161	32	20	48	1.4	51	45	52	50	\$43
1994	238	270	11	187	26	16	58	0.8	64	43	45	50	\$36
1995	134	152	6	96	31	15	54	2.7	57	71	79	71	\$32
1996	223	250	10	164	35	20	45	1.5	51	30	49	46	\$33
1997	364	401	17	270	35	16	49	1.2	60	37	43	48	\$30
1998	103	107	5	77	29	26	45	1.6	59	60	60	60	\$28
1999	206	228	8	163	18	24	58	0.8	55	59	62	60	\$24
2000	231	250	8	183	31	26	43	1.5	54	59	50	53	\$33
2001	259	278	9	213	30	21	49	1.3	52	51	53	52	\$46
2002	544	621	16	475	27	25	48	1	66	49	46	52	\$72
2003	483	518	14	425	25	13	62	0.9	61	46	53	54	\$96
2004	631	709	16	524	28	34	38	1.6	51	40	54	49	\$99
2005	590	638	14	485	25	13	62	0.8	51	48	46	48	\$96
2006	890	983	20	813	26	17	57	1.1	61	50	58	57	\$101
2007	702	758	16	633	34	14	52	1.2	55	60	47	52	\$93
2008	853	928	18	714	26	25	49	1.1	56	52	51	52	\$75
2009	884	942	18	844	23	22	55	0.9	57	46	54	53	\$43
2010	1012	1042	19	955	38	16	46	1.4	62	55	43	52	\$71
2011	1711	1898	35	1626	23	21	56	0.8	61	73	47	56	\$98

<sup>1</sup>Includes DNR and Tribal harvests

<sup>2</sup>Estimated from population model; includes estimated non-reported harvest of 10%.

<sup>3</sup>Average pelt price based on a survey of in-state fur buyers only.

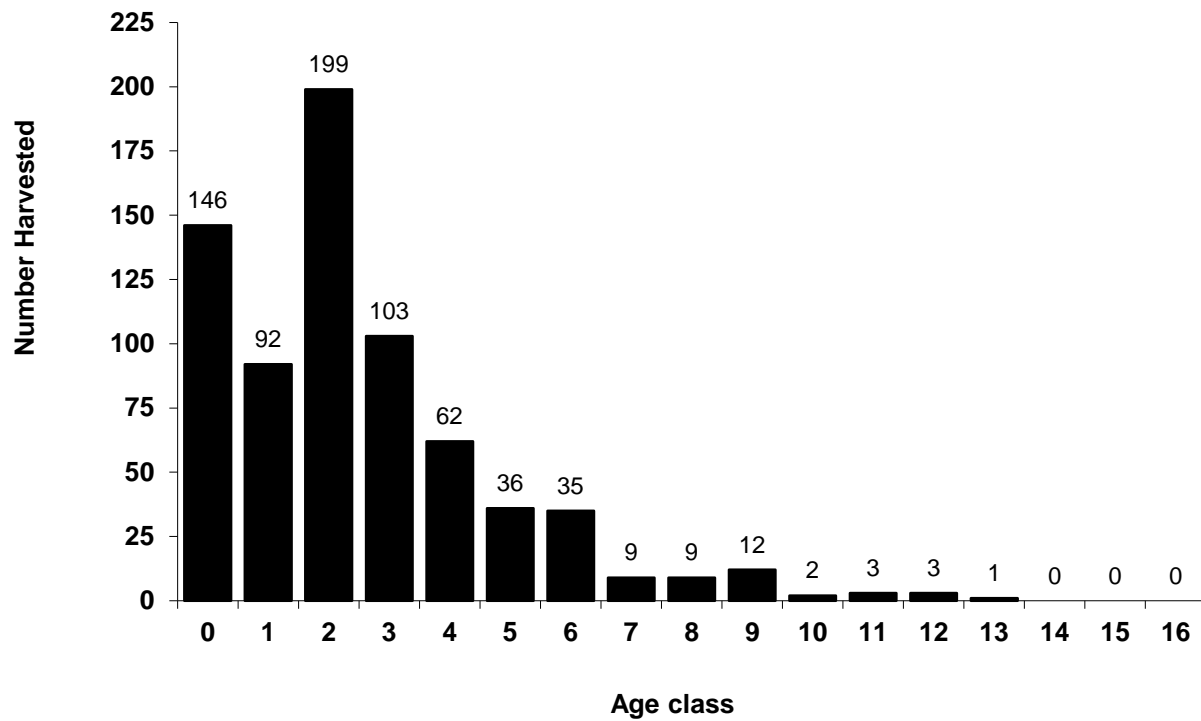


Figure 1. Age structure of female bobcats in the 2011-12 harvest.

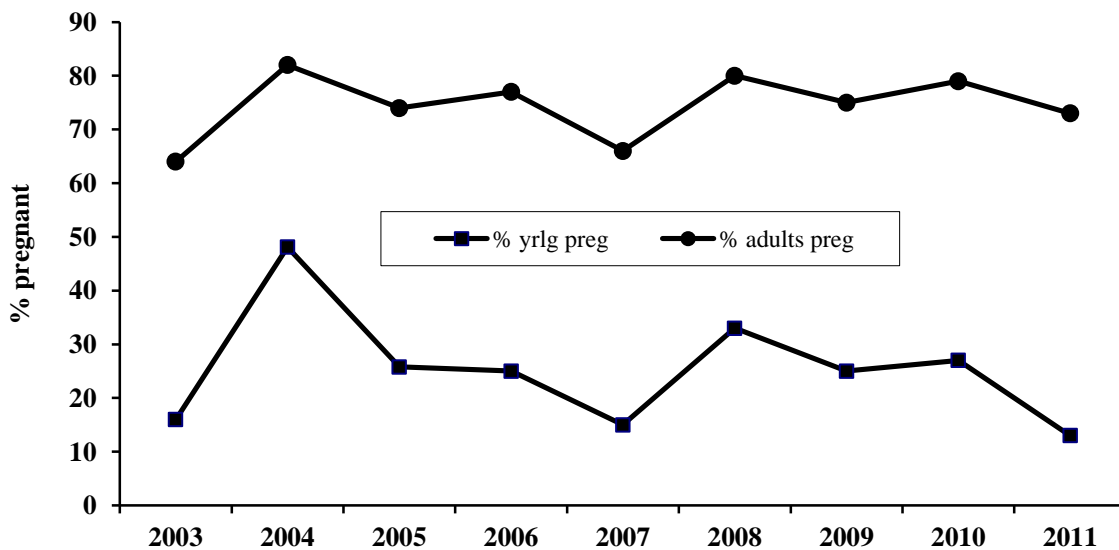


Figure 2. Pregnancy rates for yearling and adult bobcats in Minnesota, 2003-2011.

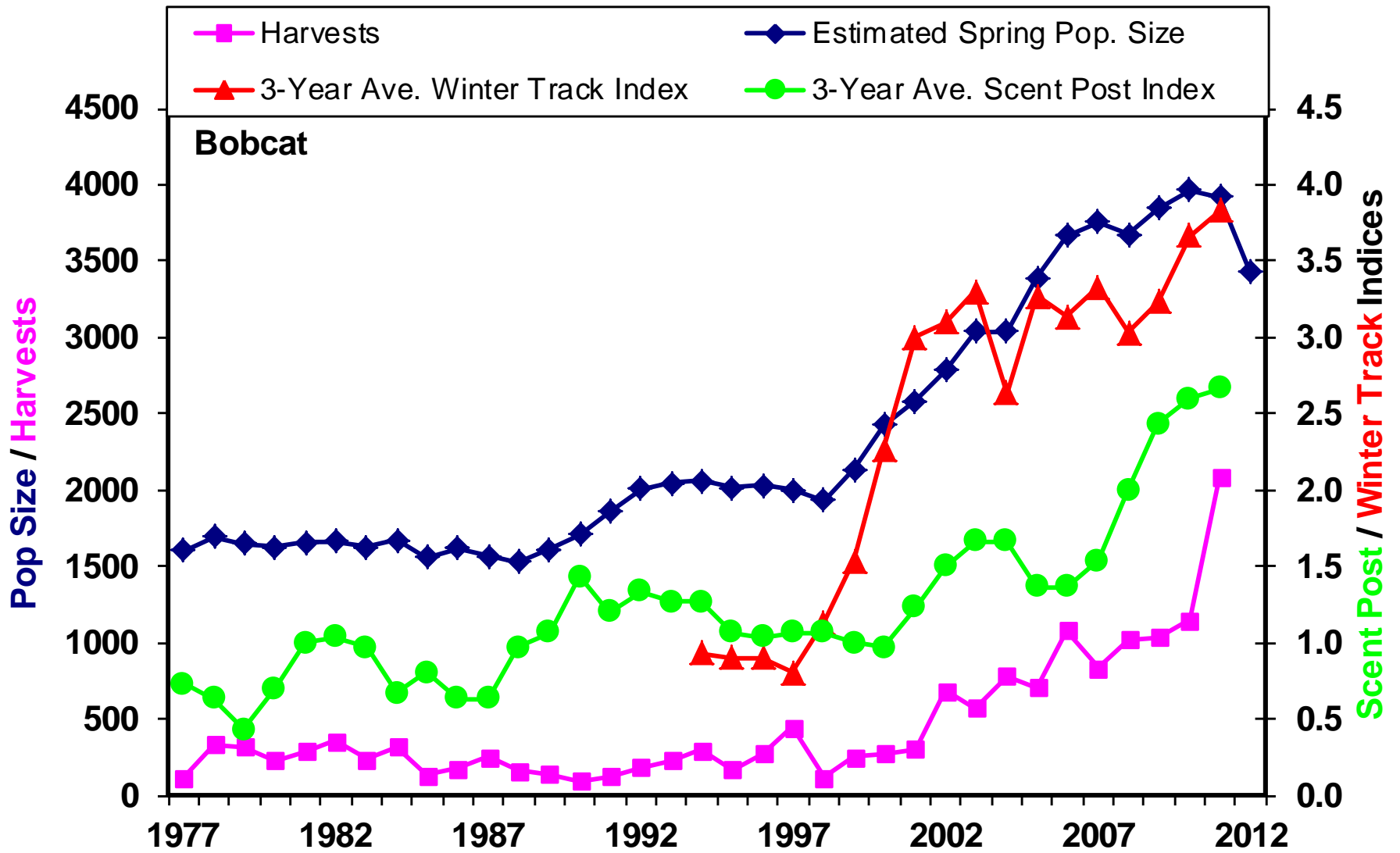


Figure 3. Bobcat populations, harvests, and survey indices, 1977-2012. Harvests include an estimate of non-reported take.

Table 2. Fisher harvest data, 1982 to 2011.

Year	DNR harvest	Modeled Harvest <sup>1</sup>	% Autumn Pop. Harvested <sup>2</sup>	Carcasses examined	% juveniles	% yearlings	% adults	Juv: Ad. Female ratio	% male juveniles	% male yearlings	% male adults	% males overall	Pelt price Males <sup>3</sup>	Pelt price Females <sup>3</sup>
1982	912	1073	16	1073	66	19	15	9.4	46	41	52	46	\$70	\$99
1983	631	735	11	662	69	18	13	8.8	45	40	40	44	\$71	\$121
1984	1285	1332	18	1270	63	20	17	7.2	52	45	45	49	\$70	\$122
1985	678	735	10	712	63	20	18	5.4	46	40	34	43	\$74	\$130
1986	1068	1186	16	1186	59	24	18	5.3	48	50	37	46	\$84	\$162
1987	1642	1749	23	1534	63	15	22	4.7	46	40	37	43	\$84	\$170
1988	1025	1050	15	805	70	15	15	6.8	48	45	33	45	\$54	\$100
1989	1243	1243	17	1024	64	19	17	5.8	47	47	36	45	\$26	\$53
1990	746	756	10	592	65	14	21	4.5	44	55	30	43	\$35	\$46
1991	528	528	6	410	66	21	13	7.8	50	52	35	48	\$21	\$48
1992	778	782	8	629	58	21	21	4.9	42	55	45	46	\$16	\$29
1993	1159	1192	11	937	59	22	19	5.3	47	37	42	44	\$14	\$28
1994	1771	1932	16	1360	56	18	26	4	47	54	44	48	\$19	\$30
1995	942	1060	9	-	-	-	-	-	-	-	-	45	\$16	\$25
1996	1773	2000	15	-	-	-	-	-	-	-	-	45	\$25	\$34
1997	2761	2974	22	-	-	-	-	-	-	-	-	45	\$31	\$34
1998	2695	2987	23	-	-	-	-	-	-	-	-	45	\$19	\$22
1999	1725	1880	16	-	-	-	-	-	-	-	-	45	\$19	\$20
2000	1674	1900	15	-	-	-	-	-	-	-	-	45	\$20	\$19
2001	2145	2362	19	-	-	-	-	-	-	-	-	54	\$23	\$23
2002	2660	3028	24	-	-	-	-	-	-	-	-	54	\$27	\$25
2003	2521	2728	22	-	-	-	-	-	-	-	-	55	\$27	\$26
2004	2552	2753	23	-	-	-	-	-	-	-	-	52	\$30	\$27
2005	2388	2454	22	-	-	-	-	-	-	-	-	52	\$36	\$31
2006	3250	3500	33	-	-	-	-	-	-	-	-	51	\$76	\$68
2007	1682	1811	21	-	-	-	-	-	-	-	-	51	\$63	\$48
2008	1712	1828	22	-	-	-	-	-	-	-	-	52	\$22	\$37
2009	1259	1323	17	-	-	-	-	-	-	-	-	53	\$35	\$34
2010	903	951	12	759	52	25	23	4.3	54	53	49	52	\$38	\$37
2011	1473	1651	21	1314	46	28	26	3	56	50	39	50	\$48	\$40

<sup>1</sup> Includes DNR and Tribal harvests

<sup>2</sup> Estimated from population model, includes estimated non-reported harvest of 22% 1977-1992, and 10% from 1993-present.

<sup>3</sup> Average pelt price based on a survey of in-state fur buyers only.

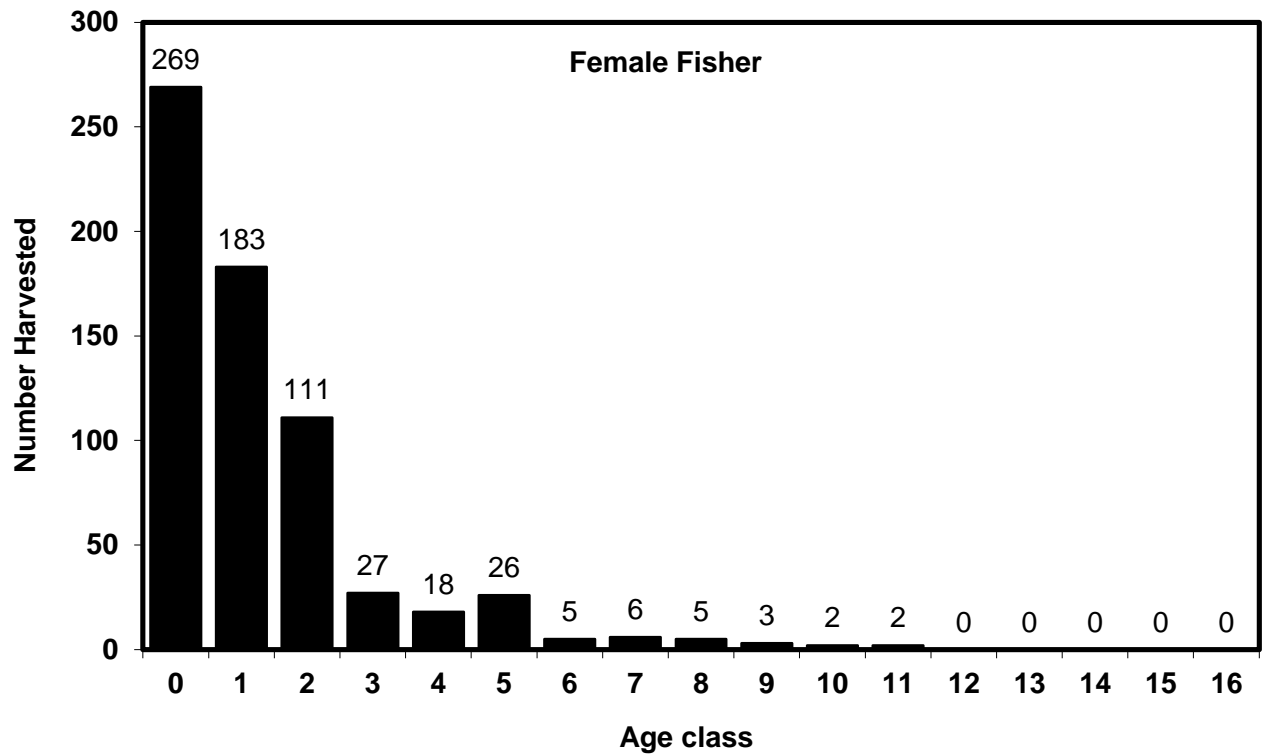


Figure 4. Age structure of female fishers in the 2011 harvest.

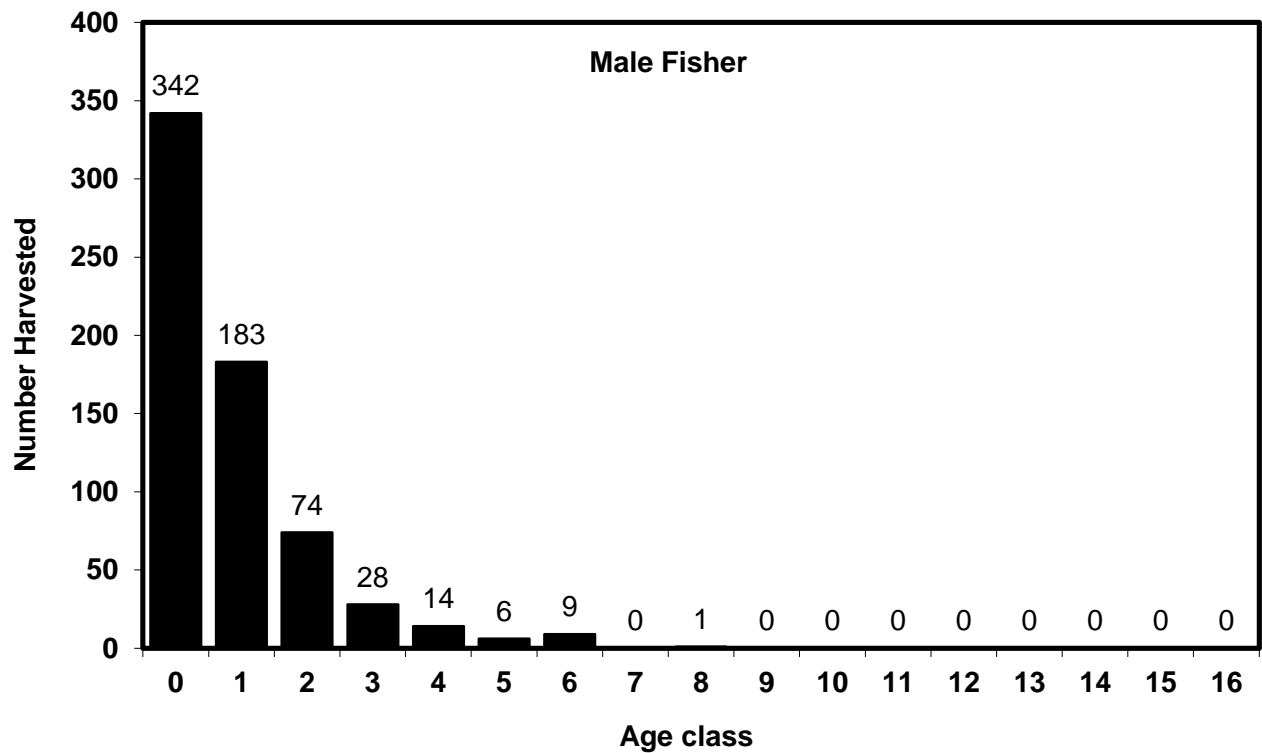


Figure 5. Age structure of male fishers in the 2011 harvest.



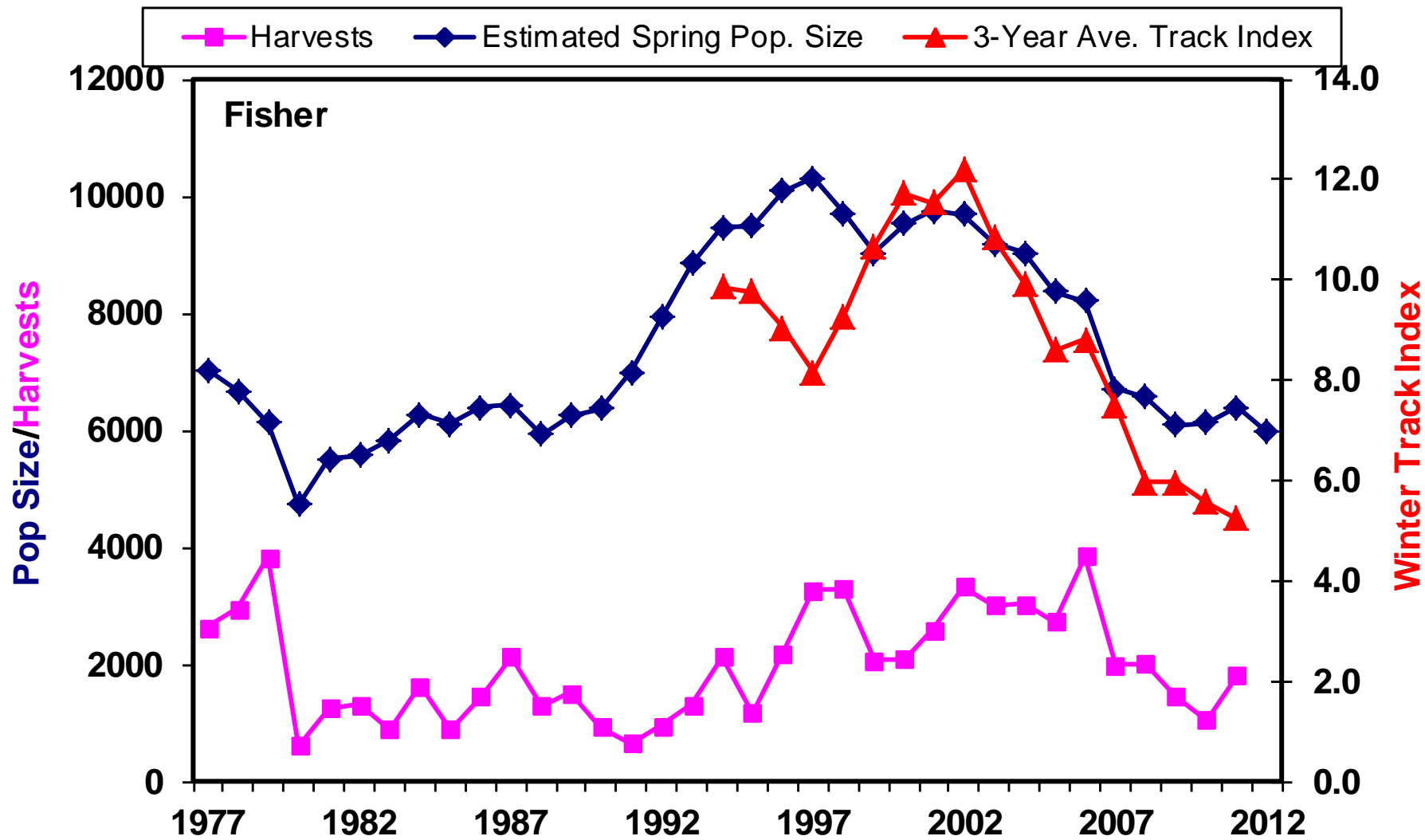


Figure 6. Fisher populations, harvests, and survey indices, 1977-2012. Harvests include an estimate of non-reported take.

Table 3. Marten harvest data, 1985 to 2011.

Year	DNR harvest	Modeled Harvest <sup>1</sup>	% Autumn Pop. Harvested <sup>2</sup>	Carcasses Examined <sup>3</sup>	% juveniles	% yearlings	% adults	Juv: Ad. Female ratio	% male juveniles	% male yearlings	% male adults	% males overall	Pelt price Males <sup>4</sup>	Pelt price Females <sup>4</sup>
1985	430	430	5	507	73	18	9	17.2	69	68	82	70	\$30	\$28
1986	798	798	9	884	64	21	15	12.3	65	71	81	69	\$36	\$27
1987	1363	1363	13	1754	66	18	16	11.2	65	67	75	67	\$43	\$39
1988	2072	2072	17	1977	66	11	23	8.6	58	50	66	59	\$50	\$43
1989	2119	2119	17	1014	68	12	20	9.7	57	63	65	59	\$48	\$47
1990	1349	1447	12	1375	48	18	34	3.6	59	54	61	59	\$44	\$41
1991	686	1000	9	716	74	9	17	16.1	69	71	72	70	\$40	\$27
1992	1602	1802	13	1661	65	18	17	15.1	63	70	75	66	\$28	\$25
1993	1438	1828	13	1396	57	20	23	7.5	61	71	67	64	\$36	\$30
1994	1527	1846	13	1452	58	15	27	6.4	62	76	67	66	\$34	\$28
1995	1500	1774	12	1393	60	18	22	8.2	63	68	66	65	\$28	\$21
1996	1625	2000	13	1372	48	22	30	4.8	62	69	67	65	\$34	\$29
1997	2261	2762	18	2238	61	13	26	6.2	60	60	63	61	\$28	\$22
1998	2299	2795	18	1577	57	18	25	6.6	62	66	65	63	\$20	\$16
1999	2423	3000	18	2013	67	12	21	9.8	65	66	67	66	\$25	\$21
2000	1629	2050	12	1598	56	25	19	8.9	62	69	66	64	\$28	\$21
2001	1940	2250	12	1895	62	15	23	11	66	73	75	69	\$24	\$23
2002	2839	3192	18	2451	39	30	31	3.1	57	63	61	60	\$28	\$27
2003	3214	3548	20	2391	48	17	35	4	57	65	66	62	\$30	\$27
2004	3241	3592	22	2776	26	28	46	1.3	52	64	57	58	\$31	\$27
2005	2653	2873	19	1992	53	16	31	4.9	64	63	65	64	\$37	\$32
2006	3788	4120	28	1914	64	17	20	9.2	66	67	65	66	\$74	\$66
2007	2221	2481	20	1355	30	29	41	1.5	56	64	50	56	\$59	\$50
2008	1823	1953	16	1095	40	21	39	2.1	58	60	53	56	\$31	\$28
2009	2073	2250	18	1252	55	16	29	4.9	65	46	61	61	\$27	\$30
2010	1842	1977	16	1202	47	29	25	4.1	69	54	60	63	\$40	\$37
2011	2525	2744	22	1615	39	25	36	2.6	63	63	59	62	\$42	\$39

<sup>1</sup> Includes DNR and Tribal harvests

<sup>2</sup> Estimated from population model; includes estimated non-reported harvest of 40% in 1985-1987 and 1991, 20% in 1988-1990 and 1992-1998, and 10% from 1999-present.

<sup>3</sup> Starting in 2005, the number of carcasses examined represents a random sample of ~ 70% of the carcasses collected in each year.

<sup>4</sup> Average pelt price based on a survey of in-state fur buyers only

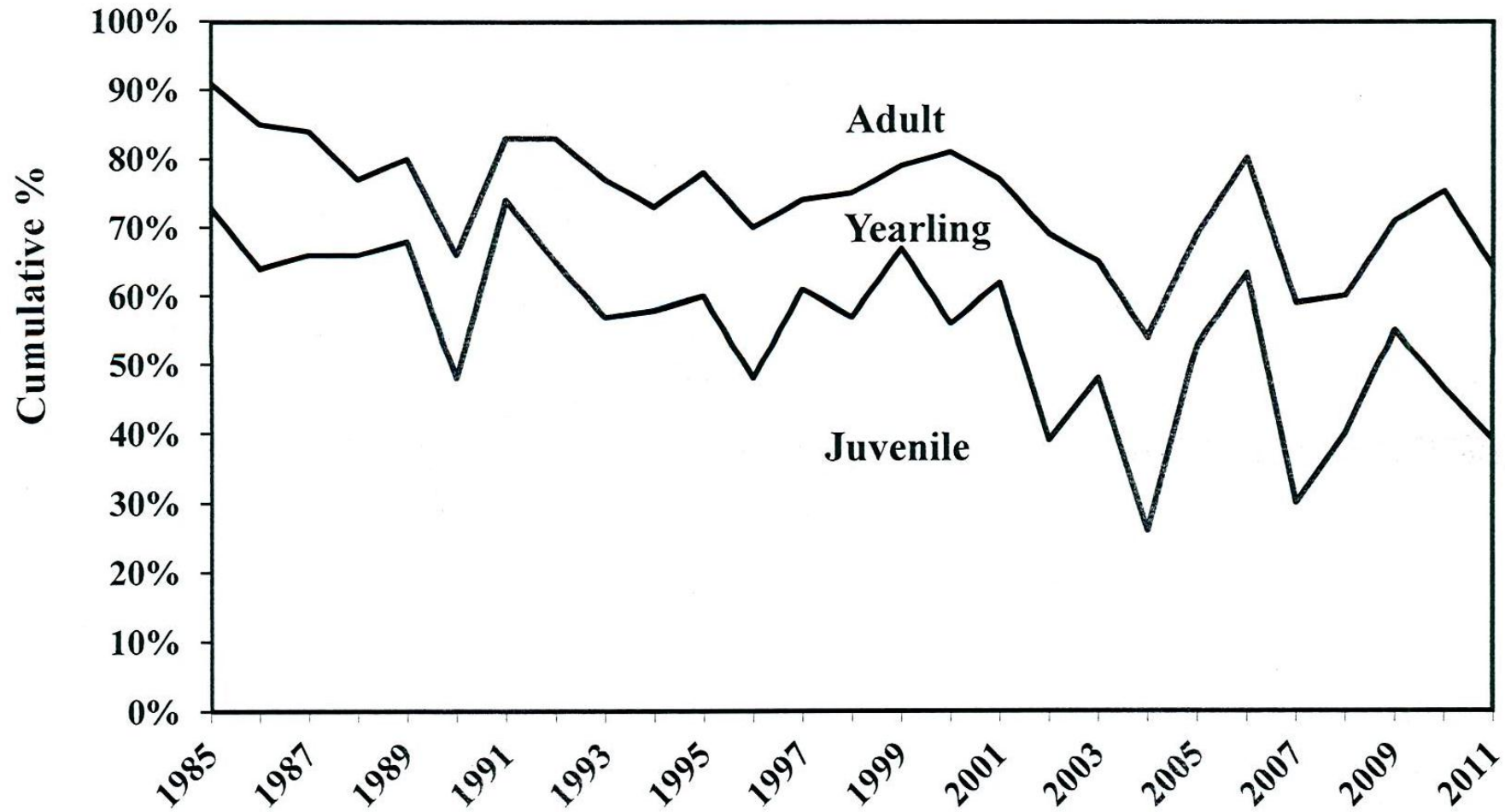


Figure 7. Marten harvest age-class proportions, 1985-2011.

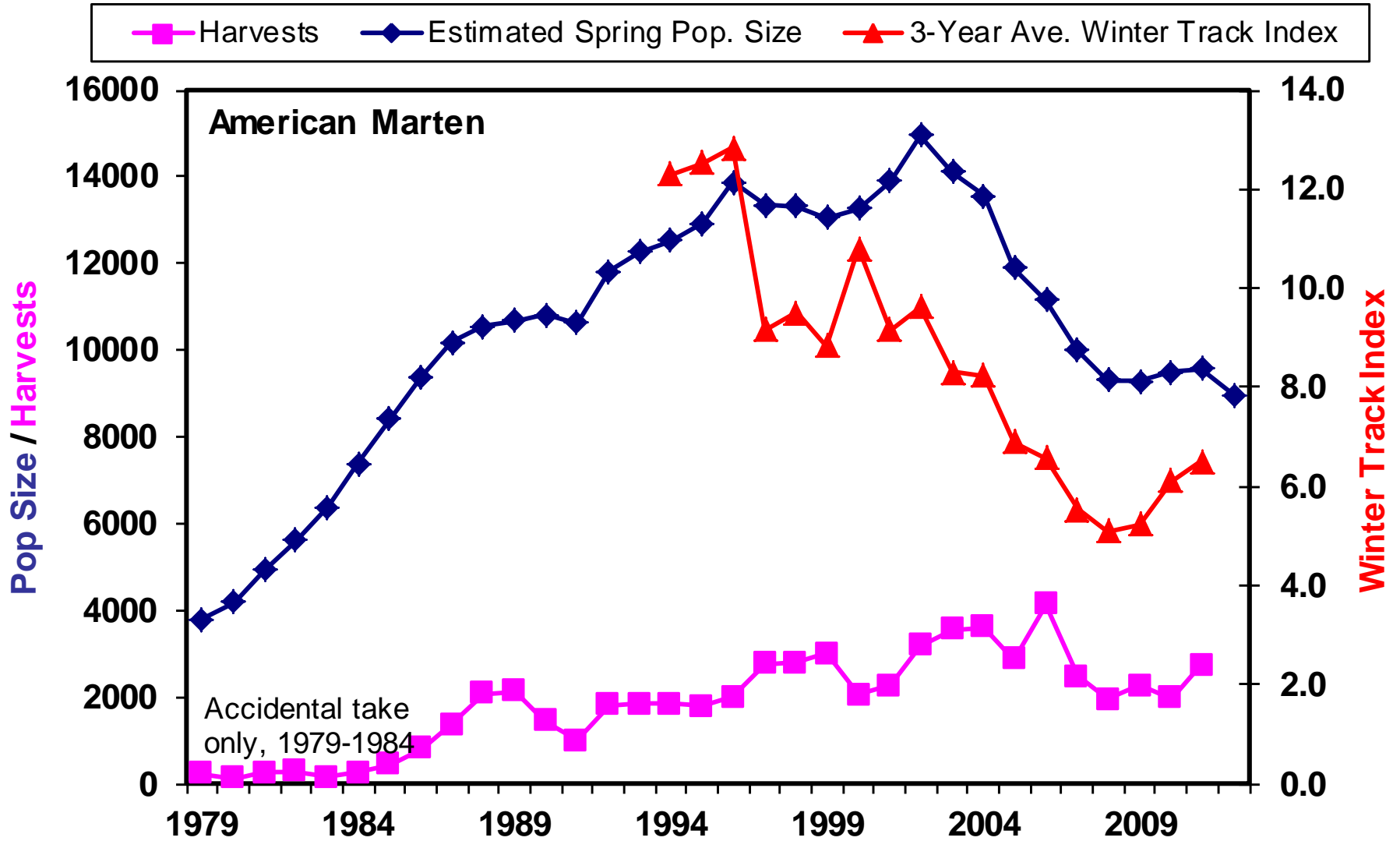


Figure 8. American marten populations, harvests, and survey indices, 1979-2012. Harvests include an estimate of non-reported take.

Table 4. Otter harvest data<sup>1</sup>, 1982 to 2011. Carcasses were only collected from 1980-86.

Year	DNR harvest	Modeled Harvest <sup>1</sup>	% Autumn Pop. Harvested <sup>2</sup>	Carcasses examined	% juveniles	% yearlings	% adults	Juv:ad. females	% male juveniles	% male yearlings	% male adults	% males overall	Pelt price Otter <sup>3</sup>	Pelt price Beaver <sup>3</sup>
1982	385	625	9	389	51	26	23	6	57	65	65	60	\$26	\$11
1983	408	604	8	433	42	31	27	3.7	56	57	57	56	\$25	\$12
1984	529	561	7	549	48	23	29	3.2	47	50	49	49	\$22	\$12
1985	559	572	7	572	43	23	34	2.2	53	50	43	51	\$21	\$15
1986	777	777	8	745	45	23	32	2.7	45	48	46	47	\$24	\$20
1987	1386	1484	15	-	-	-	-	-	-	-	-	52	\$23	\$17
1988	922	922	9	-	-	-	-	-	-	-	-	52	\$22	\$14
1989	1294	1294	12	-	-	-	-	-	-	-	-	52	\$22	\$12
1990	888	903	8	-	-	-	-	-	-	-	-	52	\$24	\$9
1991	855	925	8	-	-	-	-	-	-	-	-	51	\$25	\$9
1992	1368	1365	10	-	-	-	-	-	-	-	-	52	\$30	\$7
1993	1459	1368	10	-	-	-	-	-	-	-	-	52	\$43	\$10
1994	2445	2708	19	-	-	-	-	-	-	-	-	52	\$48	\$14
1995	1435	1646	12	-	-	-	-	-	-	-	-	52	\$39	\$12
1996	2219	2500	18	-	-	-	-	-	-	-	-	52	\$39	\$19
1997	2145	2313	17	-	-	-	-	-	-	-	-	52	\$40	\$17
1998	1946	2139	16	-	-	-	-	-	-	-	-	52	\$34	\$13
1999	1635	1717	13	-	-	-	-	-	-	-	-	52	\$41	\$11
2000	1578	1750	13	-	-	-	-	-	-	-	-	52	\$51	\$14
2001	2301	2531	18	-	-	-	-	-	-	-	-	57	\$46	\$13
2002	2145	2390	16	-	-	-	-	-	-	-	-	59	\$61	\$10
2003	2766	2966	20	-	-	-	-	-	-	-	-	57	\$85	\$12
2004	3450	3700	25	-	-	-	-	-	-	-	-	56	\$87	\$14
2005	2846	3018	22	-	-	-	-	-	-	-	-	58	\$89	\$15
2006	2720	2873	22	-	-	-	-	-	-	-	-	56	\$43	\$17
2007	1861	1911	15	-	-	-	-	-	-	-	-	55	\$29	\$16
2008	1938	1983	15	-	-	-	-	-	-	-	-	59	\$24	\$12
2009	1544	1578	12	-	-	-	-	-	-	-	-	59	\$36	\$13
2010	1814	1830	13	-	-	-	-	-	-	-	-	57	\$35	\$13
2011	2294	2490	17	-	-	-	-	-	-	-	-	58	\$51	\$17

<sup>1</sup> Includes DNR and Tribal harvests

<sup>2</sup> Estimated from population model. Incl. estimated non-reported harvest of 30% to 1991, 22% from 1992-2001, and 10% from 2002-present.

<sup>3</sup> Weighted average of spring (beaver only) and fall prices based on a survey of in-state fur buyers.

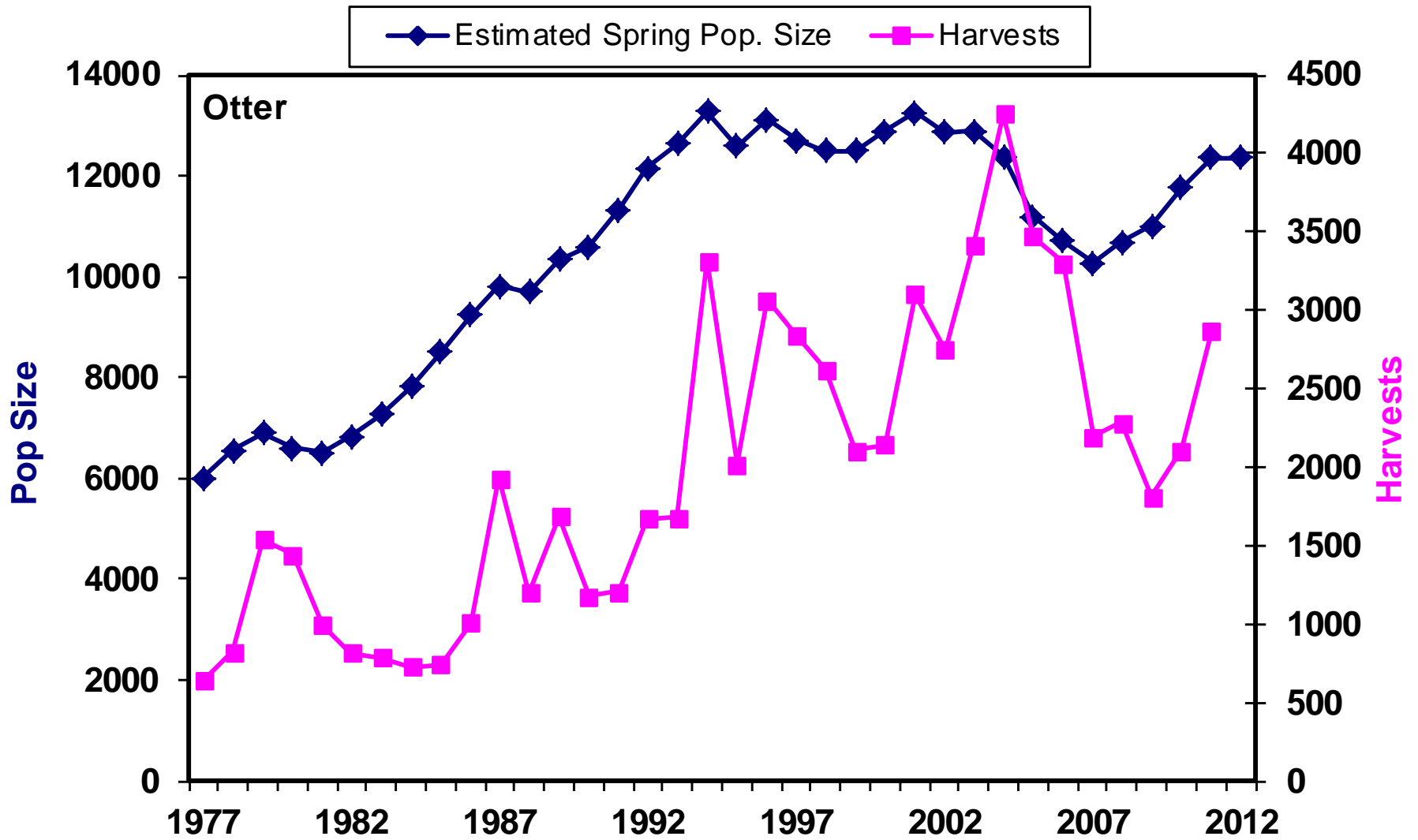


Figure 9. Otter populations and harvests, 1977-2012. Harvests include an estimate of non-reported take.